

SpaceOps 2014 Abstract Submission

Title: Use of Semi-Autonomous Tools for ISS Commanding and Monitoring

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Proposed Track: Operations Concepts, Methods, Systems, and Automation

As the International Space Station (ISS) has moved into a utilization phase, operations have shifted to become more ground-based with fewer mission control personnel monitoring and commanding multiple ISS systems. This shift to fewer people monitoring more systems has prompted use of semi-autonomous console tools in the ISS Mission Control Center (MCC) to help flight controllers command and monitor the ISS. These console tools perform routine operational procedures while keeping the human operator “in the loop” to monitor and intervene when off-nominal events arise. Two such tools, the Pre-positioned Load (PPL) Loader and Automatic Operators Recorder Manager (AutoORM), are used by the ISS Communications RF Onboard Networks Utilization Specialist (CRONUS) flight control position. CRONUS is responsible for simultaneously commanding and monitoring the ISS Command & Data Handling (C&DH) and Communications and Tracking (C&T) systems.

PPL Loader is used to uplink small pieces of frequently changed software data tables, called PPLs, to ISS computers to support different ISS operations. In order to uplink a PPL, a data load command must be built that contains multiple user-input fields. Next, a multiple step commanding and verification procedure must be performed to enable an onboard computer for software uplink, uplink the PPL, verify the PPL has incorporated correctly, and disable the computer for software uplink. PPL Loader provides different levels of automation in both building and uplinking these commands. In its manual mode, PPL Loader automatically builds the PPL data load commands but allows the flight controller to verify and save the commands for future uplink. In its auto mode, PPL Loader automatically builds the PPL data load commands for flight controller verification, but automatically performs the PPL uplink procedure by sending commands and performing verification checks while notifying CRONUS of procedure step completion. If an off-nominal condition occurs during procedure execution, PPL Loader notifies CRONUS through popup messages, allowing CRONUS to examine the situation and choose an option of how PPL loader should proceed with the procedure. The use of PPL Loader to perform frequent, routine PPL uplinks offloads CRONUS to better monitor two ISS systems. It also reduces procedure performance time and decreases risk of command errors.

AutoORM identifies ISS communication outage periods and builds commands to lock, playback, and unlock ISS Operations Recorder files. Operation Recorder files are circular buffer files of continually recorded ISS telemetry data. Sections of these files can be locked from further writing, be played back to capture telemetry data that occurred during an ISS loss of signal (LOS) period, and then be unlocked for future recording use. Downlinked Operation Recorder files are used by mission support teams for data analysis, especially if failures occur during LOS. The commands to lock, playback, and unlock Operations Recorder files are encompassed in three different operational procedures and contain multiple user-input fields. AutoORM provides different levels of automation for building and uplinking the commands to lock, playback, and unlock Operations Recorder files. In its automatic mode, AutoORM automatically detects ISS LOS periods, then generates and uplinks the commands to lock, playback, and unlock Operations Recorder files when MCC regains signal with ISS. AutoORM also features semi-autonomous and manual modes which integrate CRONUS more into the command verification and uplink process. AutoORMs ability to automatically detect ISS LOS periods and build the necessary commands to preserve, playback, and release recorded telemetry data greatly offloads CRONUS to perform more high-level cognitive tasks, such as mission planning and anomaly troubleshooting. Additionally, since Operations Recorder commands contain numerical time input fields which are tedious for a human to manually build, AutoORM’s ability to automatically build commands reduces operational command errors.

PPL Loader and AutoORM demonstrate principles of semi-autonomous operational tools that will benefit future space mission operations. Both tools employ different levels of automation to perform simple and routine procedures, thereby offloading human operators to perform higher-level cognitive tasks. Because both tools provide procedure execution status and highlight off-nominal indications, the flight controller is able to intervene during procedure execution if needed. Semi-autonomous tools and systems that can

perform routine procedures, yet keep human operators informed of execution, will be essential in future long-duration missions where the onboard crew will be solely responsible for spacecraft monitoring and control.